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System-level Mobile device for radio frequency interference analysis

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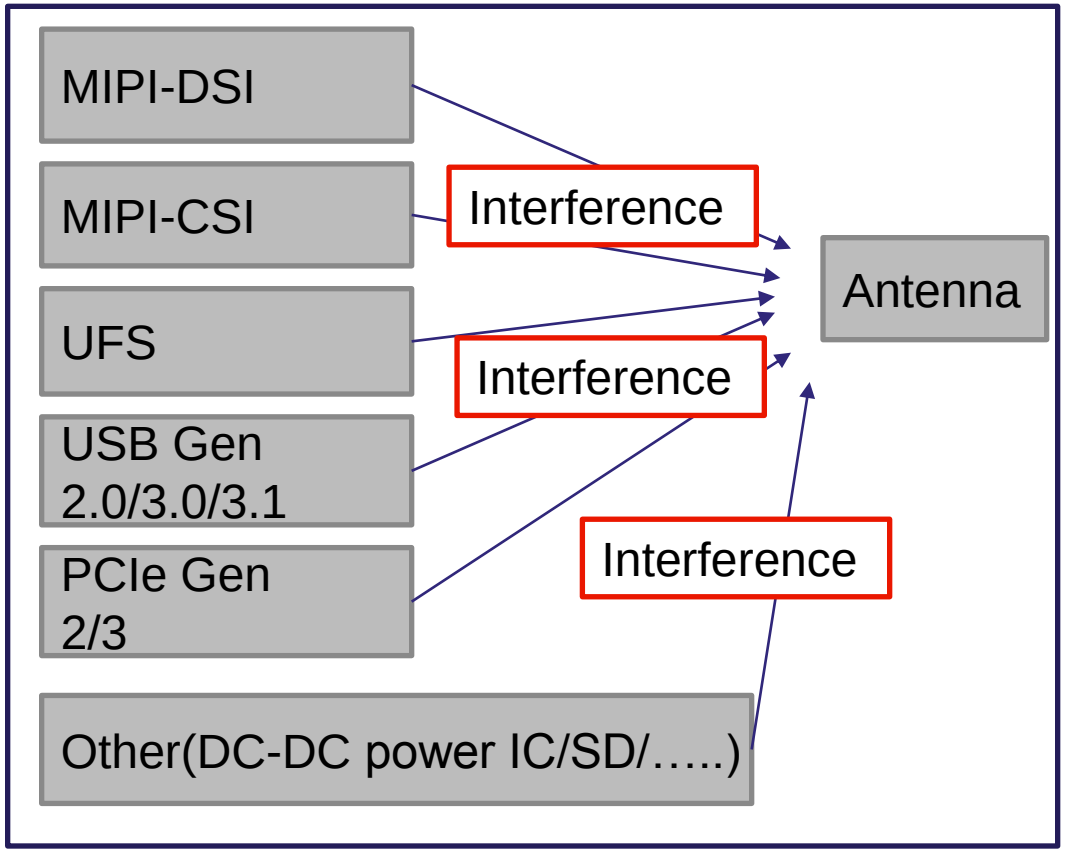
Agenda

- Design Challenge:
  - System-level of Mobile device for radio frequency interference analysis
  - The most efficient solution in FPC to meet RFI and SI requirement
- Individual areas can be analyzed separately and efficiently
  - Case1: Package substrate type for radiation emission
  - Case 2: Folded/PIFA/Loop antenna radiation pattern
  - Case 3: WLAN: 2.4 GHz RF transceivers analysis
- Solution to Design Challenge
  - Case study
- Summary

Design Challenge:

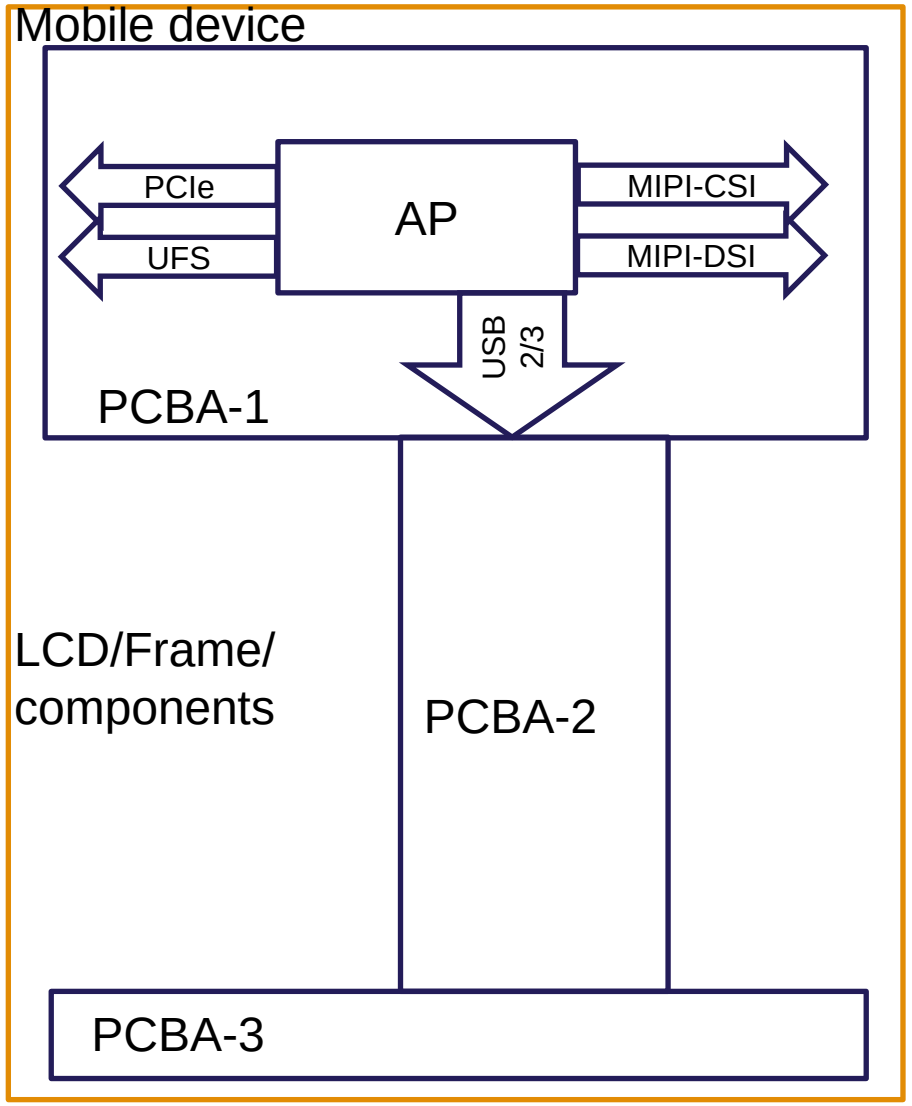
System-level of Mobile device for radio frequency interference analysis



Introduction:
With increasing wireless electronic system demands for performance and data throughput requirement, the requirement of Radio-frequency interference (RFI) integrity has become one of the most challenging tasks for integrating modern mobile devices including multi signal interfaces and multi antennas.

Design Challenge:

System-level of Mobile device for radio frequency interference analysis



Challenge 1: Multiple signal interfaces in multiple PCBs to be considered.
→3D EM tool. (A lot of resource)

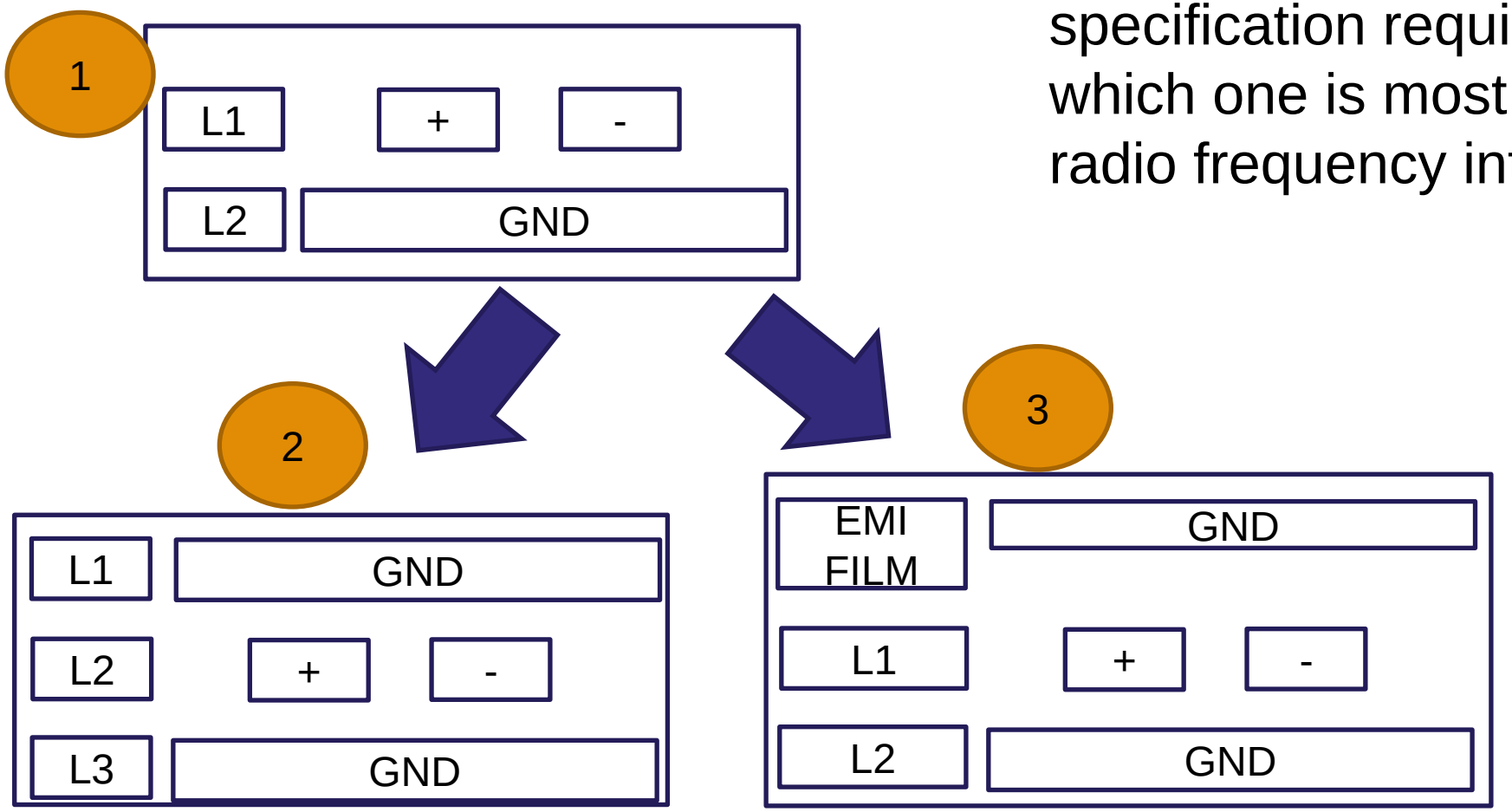
Challenge 2: Antenna to be considered to understand noise floor caused by high speed interface. (PCB and Antenna co-sim to solve De-sense issue.)
→3D EM tool. (A lot of resource)

Challenge 3: Simplify the structure Mobile device including frame/LCD/other components.
→3D EM tool. (A lot of resource)

Design Challenge:

Which one is the most efficient solution in PCB-2 to meet RFI and SI requirement

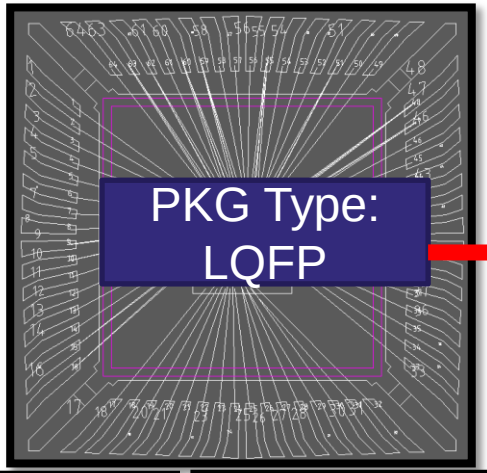
- PCBA-2 solution:

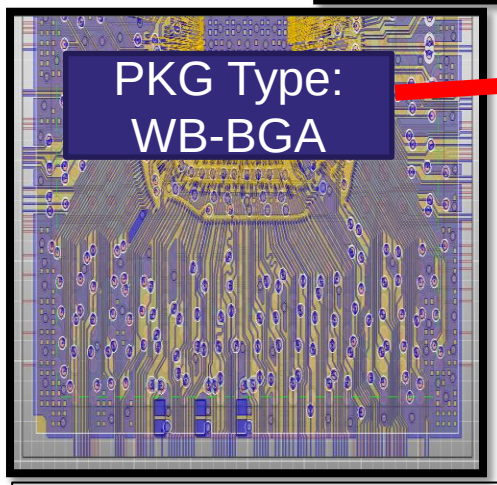


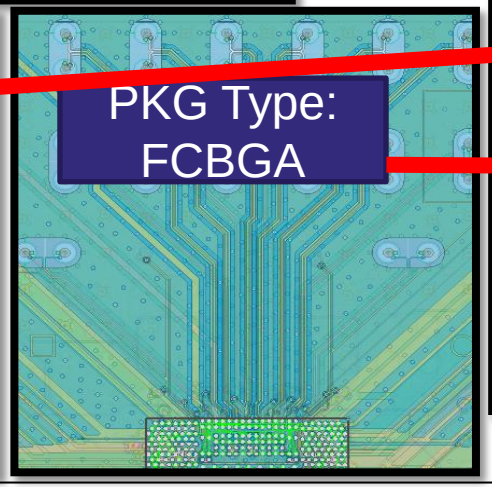
Challenge 1: If signal integrity meets the specification requirement with solution 1/2/3, which one is most efficient solution to solve radio frequency interference issue???

Case1: Individual areas can be analyzed separately and efficiently

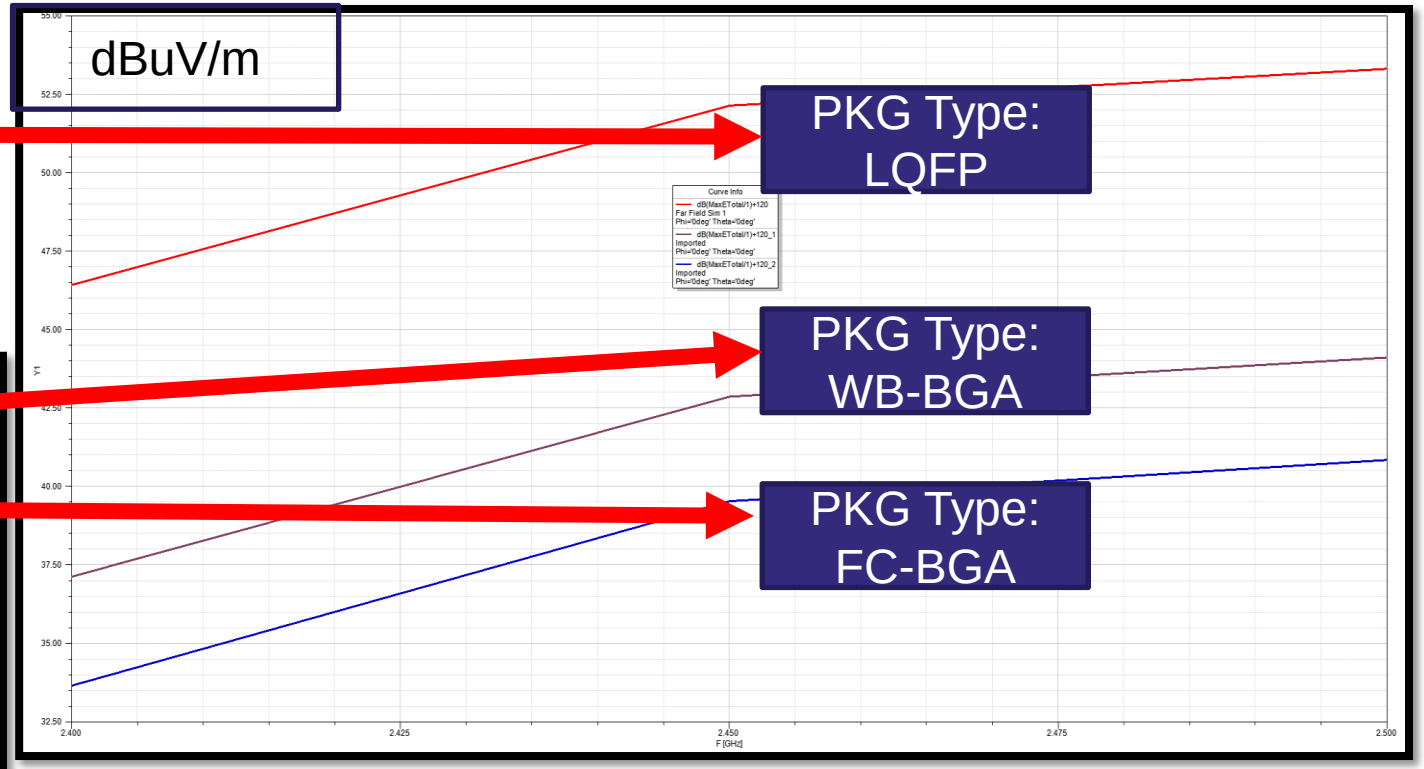
Package substrate type for radiation emission result (FC-BGA/WB-BGA/LQFP)







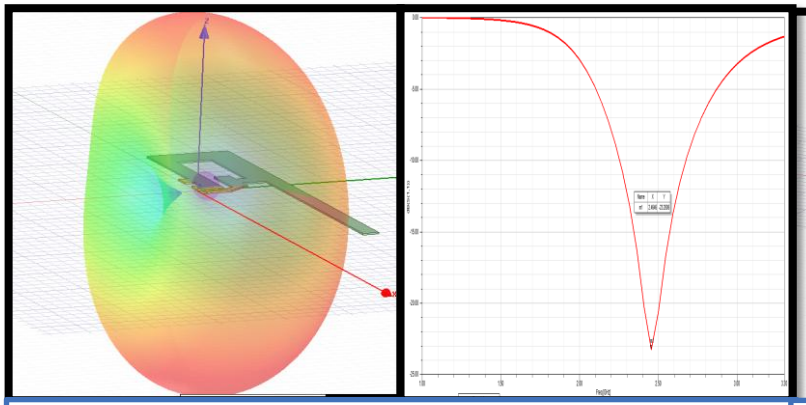
EMI result



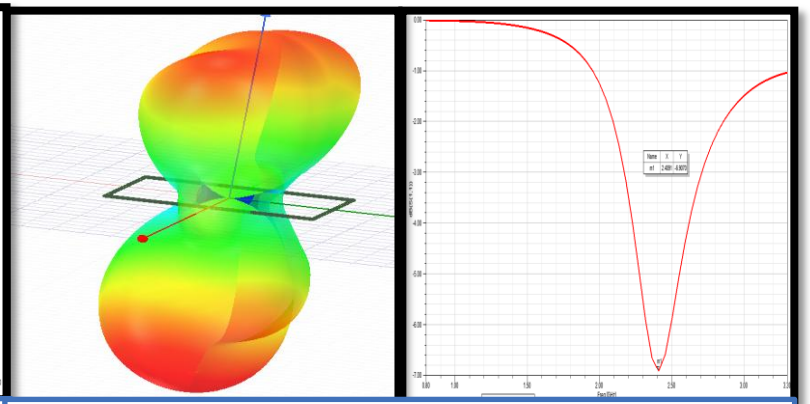
Package substrate radiation emission can be quickly analyzed near field and far field radiation through 2.5D/3D simulation tool analysis. Fully package layout/circuit can be considered and solved efficiently.

Case2: Individual areas can be analyzed separately and efficiently

Folded/PIFA/Loop antenna radiation pattern

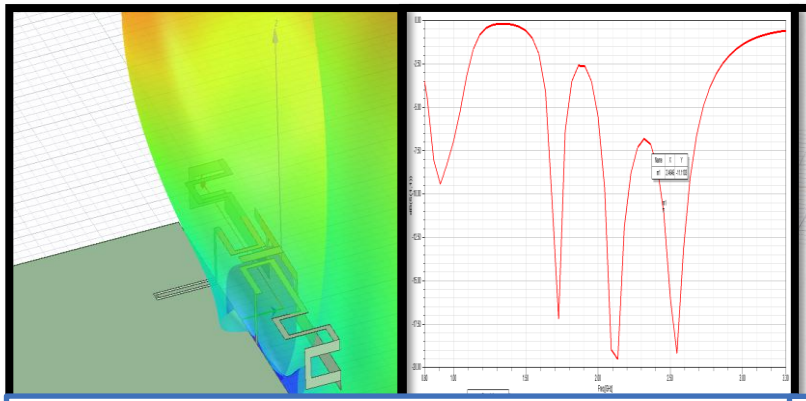


Compact PIFA antenna(~2.45GHz)

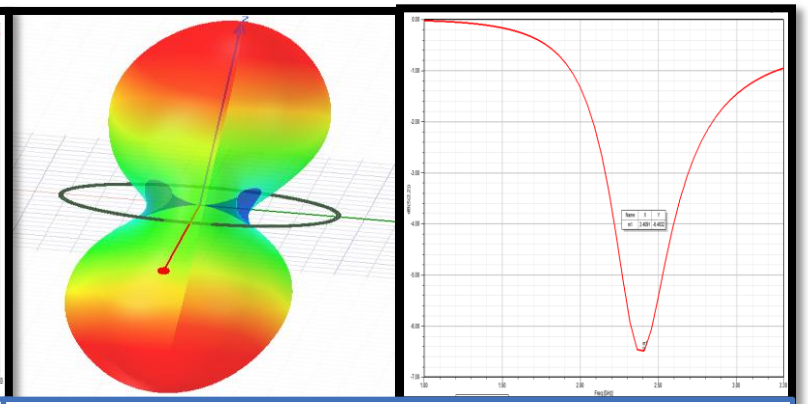


Square Loop antenna(~2.45GHz)

Antenna radiation emission can be quickly analyzed near field,S11 and far field radiation through 3D simulation tool analysis. Fully antenna layout can be considered and solved efficiently.



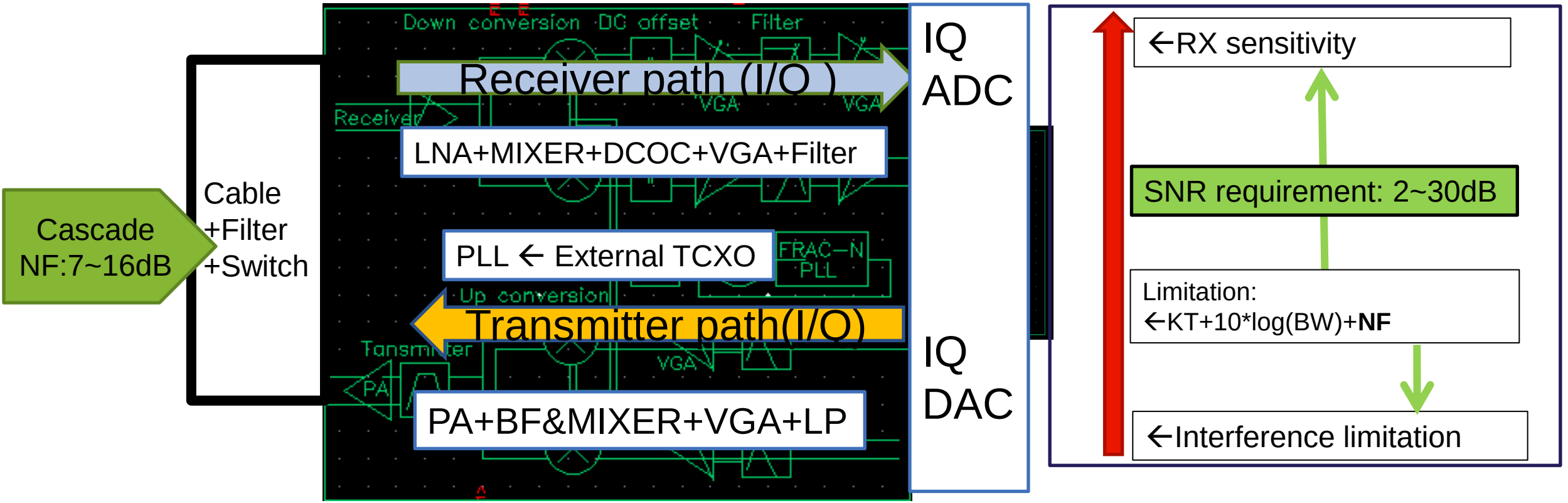
Folded loop with multiple resonant modes antenna (0.9/1.7/2.1/2.5GHz)



Circular Loop antenna(~2.45GHz)

Case3: Individual areas can be analyzed separately and efficiently

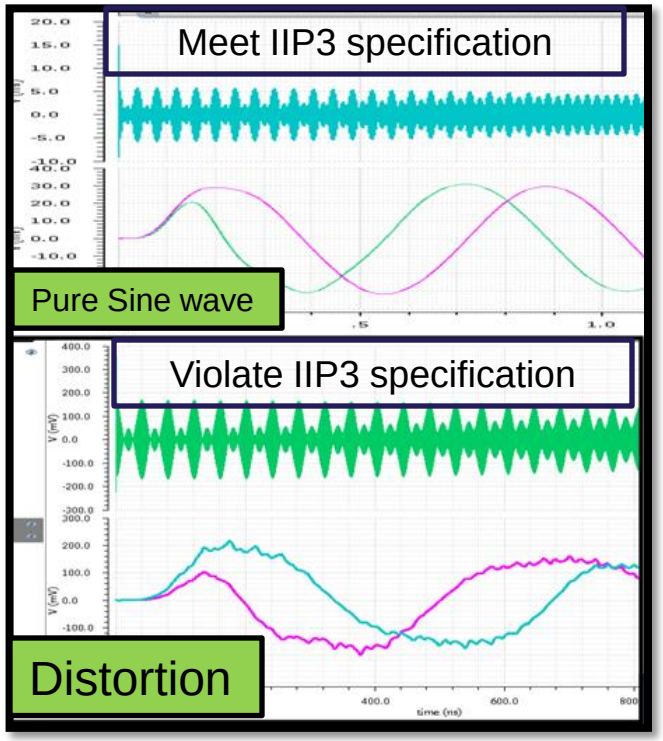
WLAN: 2.4 GHz RF transceivers analysis

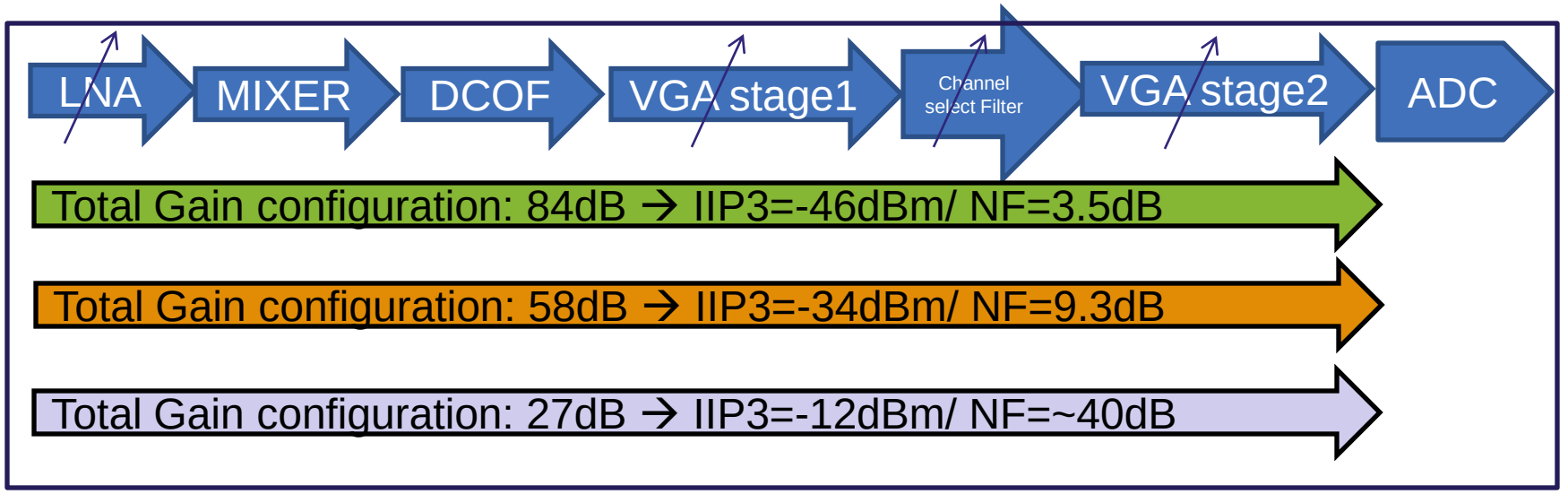


This summarizes mainly the detailed calculations of receiver (RX) noise figure (NF), RX sensitivity and radio frequency interference Noise level limitation requirement. Transmitter shows gain, filtering, mixing, and amplification to push the transmitter output. The Receiver shows amplification, demodulation, gain, DC offset cancellation and bandwidth filtering to push the receiver output.

Case3: Individual areas can be analyzed separately and efficiently

WLAN: 2.4 GHz RF transceivers analysis

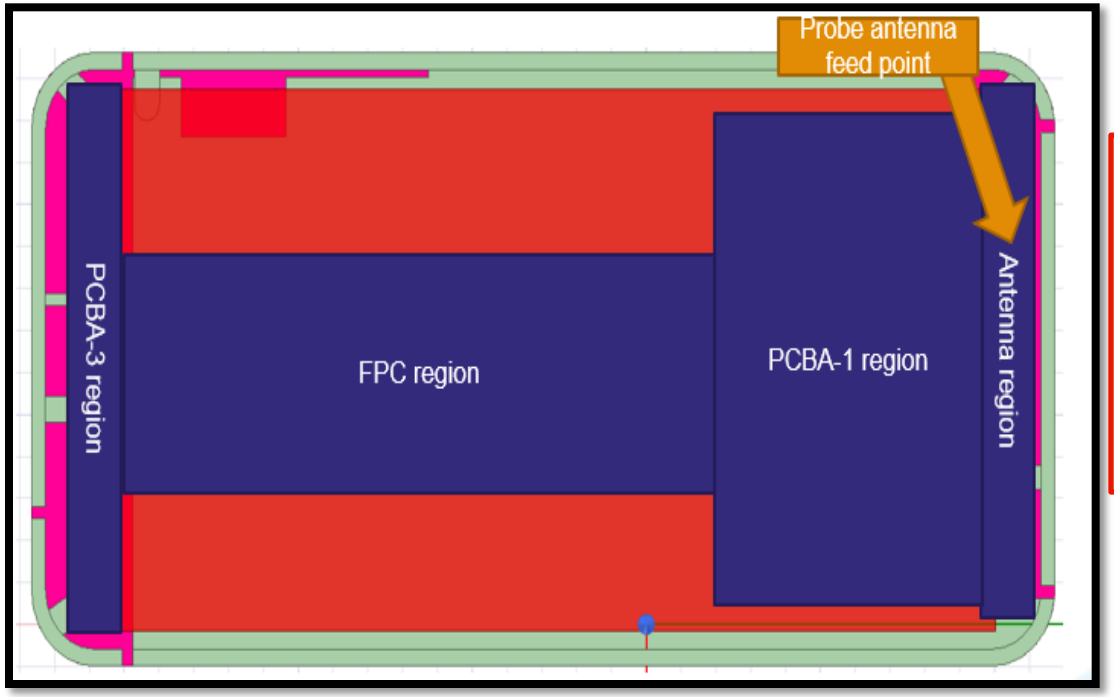




This summarizes mainly the detailed calculations of receiver (RX) noise figure (NF), RX sensitivity and radio frequency interference Noise level limitation requirement. Transmitter shows gain, filtering, mixing, and amplification to push the transmitter output. The Receiver shows amplification, demodulation, gain, DC offset cancellation and bandwidth filtering to push the receiver output. Analysis shows worst case NF value.

Solution to Design Challenge:

Huygens's box (near-field to far-field transformation)



High Risk →

1. **Optimize PCBA**
2. **Optimize antenna keepout region**
3. Heat sink shape and screw location.
4. …etc.

Multiple PCBA SI/PI solved in 2.5D tool

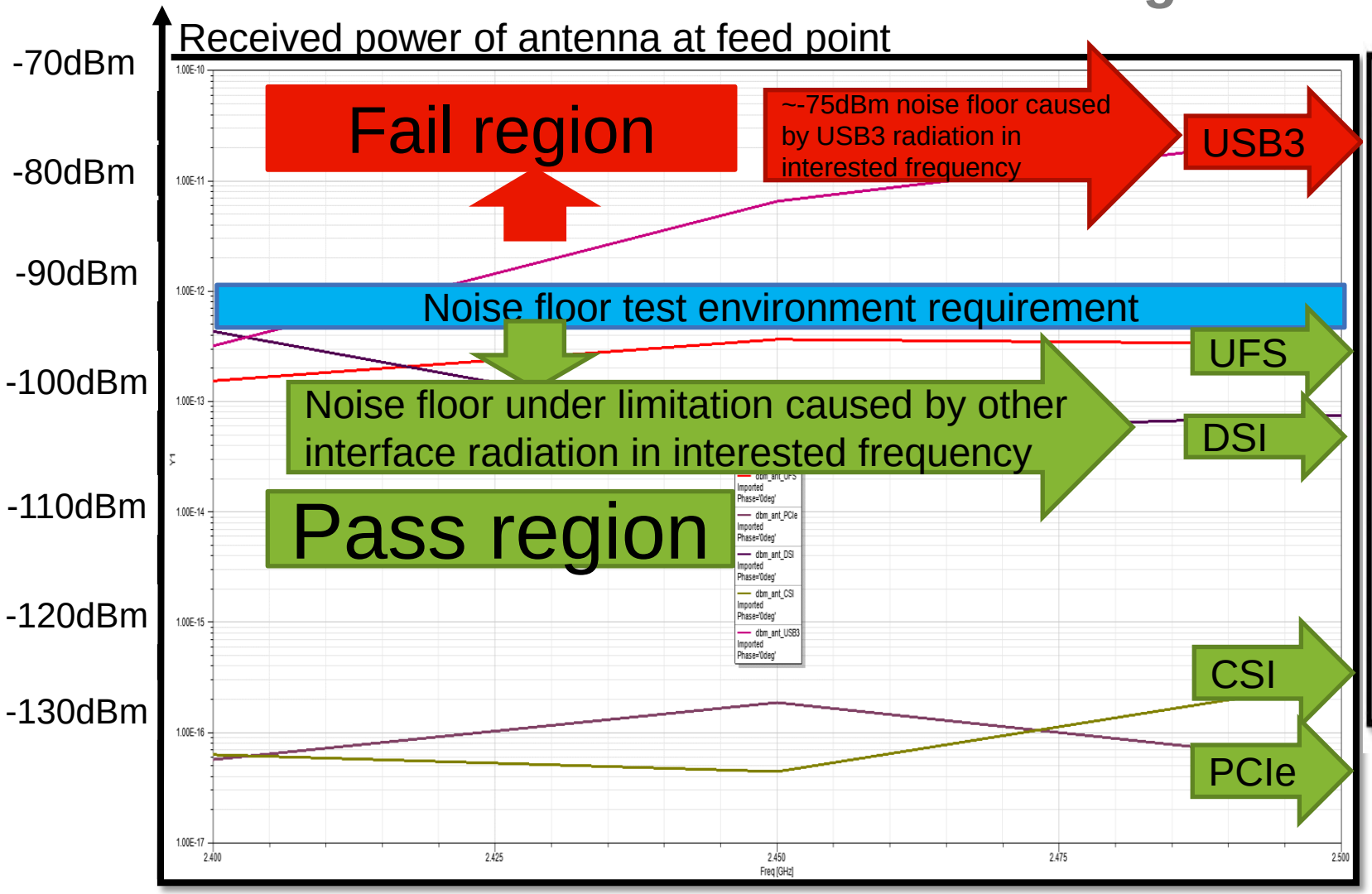
Multiple PCBA Near Field solved in 2.5D tool

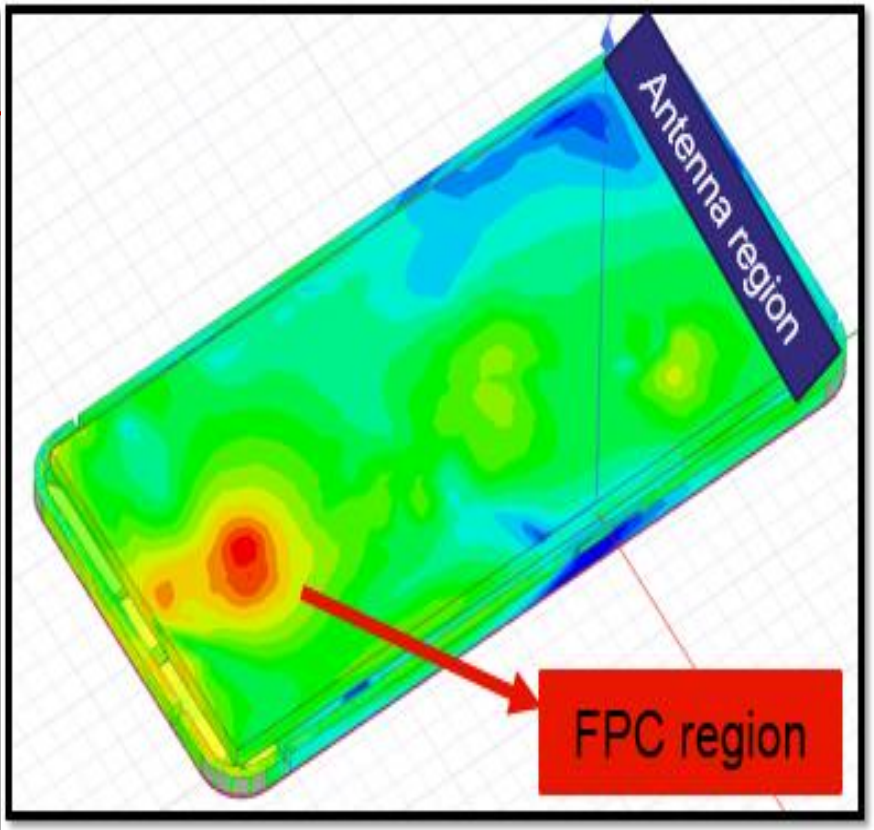
Replace multiple PCBA with noise source and co-sim with antenna /housing/Heat sink solved in 3D tool

Low Risk

An efficient approach to extracting the Near field profile of PCBA was recently introduced and was performed by the Near- Field to Far-Field transformation in papers study recently.

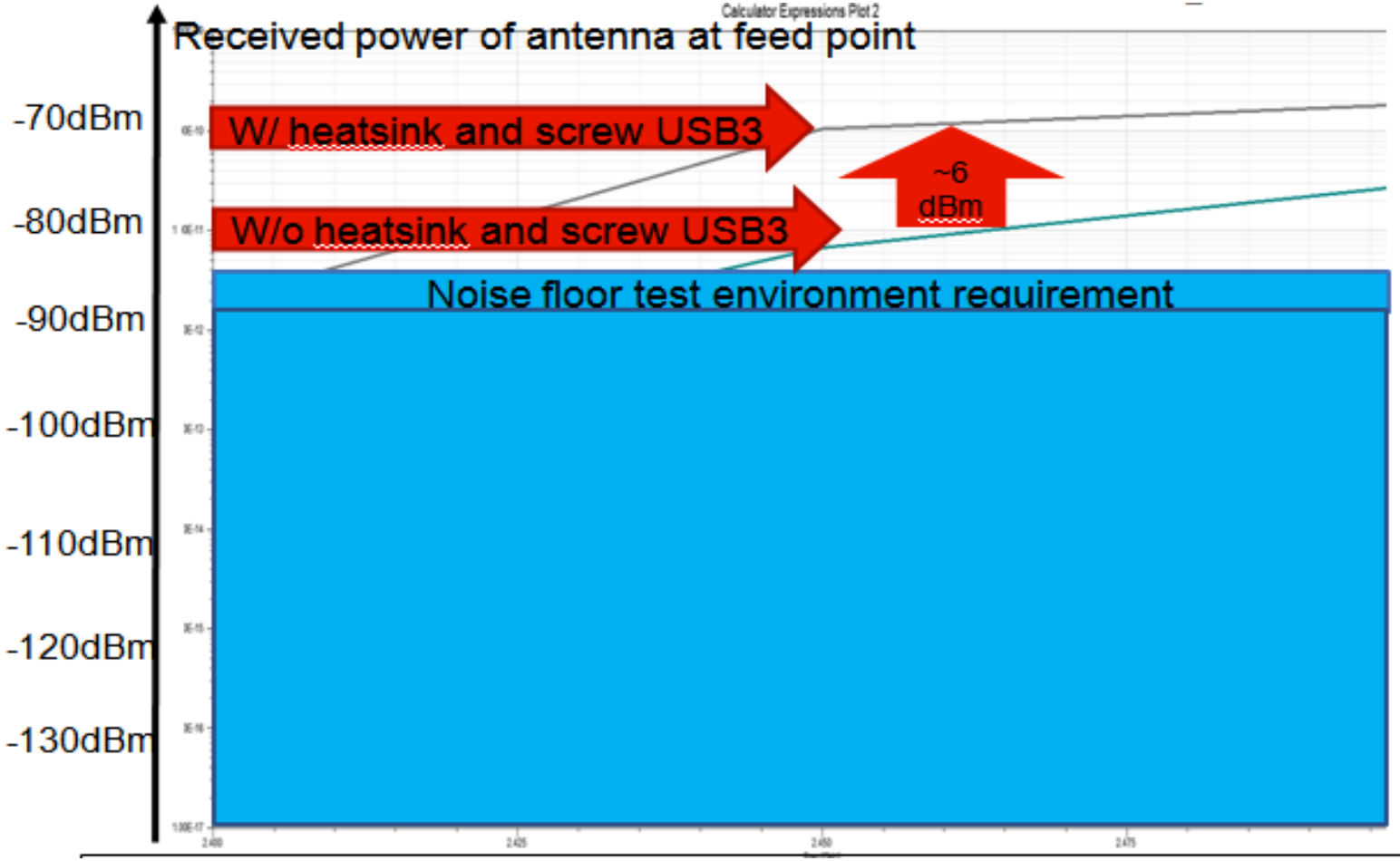
Efficient solution to find RFI-violated signal interface and hot spot region

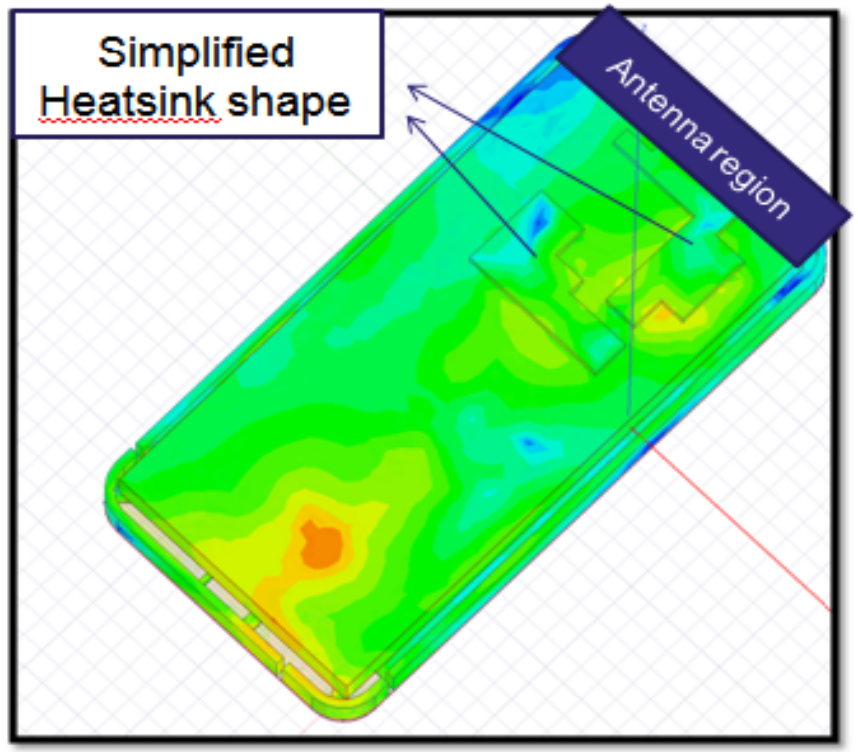




It is clear that we found the RFI-violated signal interface and hot spot region w/ received power of antenna feed point and Near-filed scan in 3D EM tool.

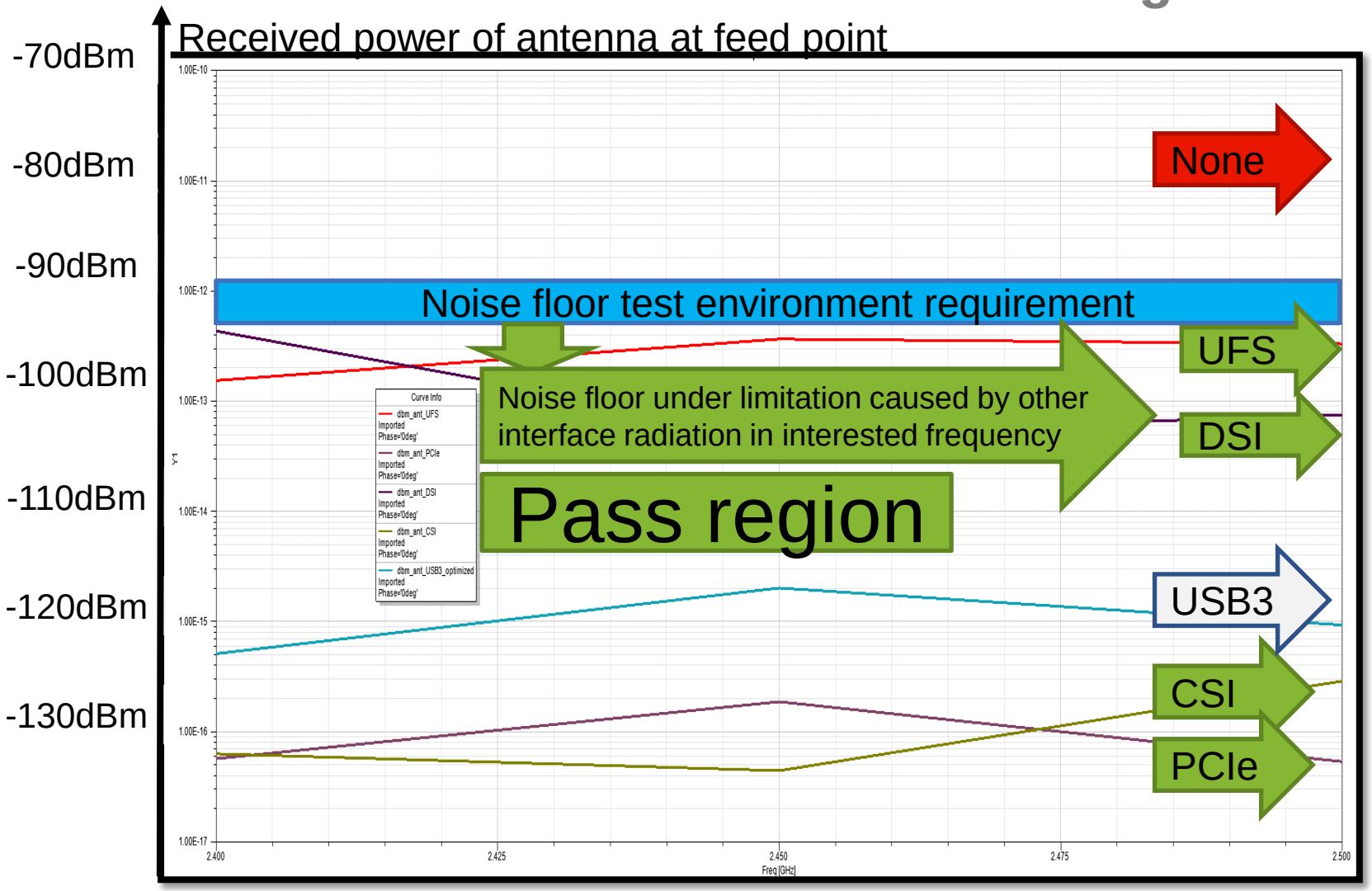
Efficient solution to find RFI-violated signal interface and hot spot region





It is clear that we found the heat-sink and screw are good conducted emissions paths in 3D EM tool.

Efficient solution to find RFI-violated signal interface and hot spot region



PCBA-1/FPC/PCBA-3 Layout solution:

1. Connector pin definition optimization
2. P/G Reference plane integrity
3. Signal/GND transition via location
4. AC cap location
5. CMF location
6. EMI dual side film
7. Connection region optimization
8. Mesh hole size of FPC optimization
9. Heat sink shape and screw location

→Successful RFI suppression layout optimization.

It is clear that we optimize the RFI-violated signal interface and hot spot region w/ received power of antenna feed point and Near-filed scan in 3D EM tool.

Summary

- A efficient method to predict RFI integrity risk in complicated system-level mobile devices is proposed.
- The methodology is based on the transformation of Near-field to Field which provides precaution in post-layout design stage.
- It gives quick method to evaluate RFI integrity risk into PCBA/Heatsink design field and optimization direction.